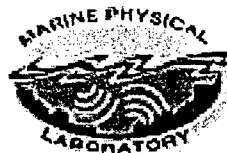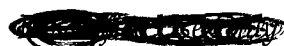# Marine Physical Laboratory

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Tow-Ship Noise

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Abstract

Geoacoustic inversion from tow-ship noised data acquired on a horizontal towed array is discussed. Through simulations and experimental results, it is shown that even very quiet ships radiate sufficient noise power to enable self-noise inversion of basic geoacoustic parameters such as effective bottom velocity.

Research Summary

The two fundamental components of the ambient noise background in the ocean are man-made (predominantly the radiated signatures of surface ships) and natural (e.g. noise originating at the surface due to breaking wave events and sounds from biological sources). Due to their relatively close proximity, towed arrays are particularly susceptible to the radiated signature of the tow ship. Although this own-ship noise can inhibit the detection of weak targets of interest, it also can be utilized as a source of opportunity for estimating the geoacoustic characteristics of the seafloor. Transmission loss and hence performance prediction in a bottom interacting environment depends strongly on these characteristics.

The estimation of geoacoustic parameters of marine sediments and subsediment layers involves the measurement of acoustic fields in the ocean waveguide for comparison with accurate forward propagation models. Conventionally, the data upon which inversions are based often are acquired from vertical arrays in the far field of the source, yielding parameter estimates averaged over the intervening environment. While vertical array technology and associated techniques have reached a high level of refinement, horizontal arrays towed by ships present definite operational advantages in terms of mobility and localization of the measurements. Spot measurements of geoacoustic parameters, sensitive only to bottom conditions between a tow ship and array, can form useful inputs to range-dependent propagation models and geophysical surveys.

Commonly, scientific and commercial applications of towed arrays have required dedicated acoustic sources to be towed in addition to the array. Such dedicated sources, along with their high-power control equipment, add expense and complexity to geoacoustic surveying. This has lead to interest in self-noise inversion where plant and

hydrodynamic noise generated by the tow ship itself are received on the array and processed to extract estimates of local geoacoustic parameters such as bottom velocity.

In this research, self-noise geoacoustic inversion has been examined from the standpoint of near-field matched-field processing (MFP). Initially, solution of the geoacoustic inversion problem itself was posed in a multiparameter optimization framework and solved via an efficient global search based on genetic algorithms (GA). The robustness of the proposed inversion method was investigated by estimating effective bottom velocities from experimental data acquired during an experiment conducted north of Elba Island, Italy, in 2000. The results were particularly encouraging because they represent somewhat a worst case scenario involving a very quiet tow ship operating at low speed in a severely cluttered interference environment due to the presence of nearby shipping. The major conclusion was that MFP in conjunction with global search procedures such as genetic algorithms is sufficiently sensitive in the near field to permit robust first-order inversion of seafloor p-wave velocity in addition to several important geometrical parameters such as water depth, source range, and array shape.

In a second look at the tow-ship noise inversion problem, a different paradigm to its solution was applied in order to better quantify the parameter sensitivity limits of near-field inversion. Gibbs sampling was used to obtain joint and marginal posterior probability densities for seabed parameters. The advantages of viewing parameter estimation problems from such a probabilistic perspective include better quantified uncertainties for inverted parameters as well as the ability to compute Bayesian evidence for a range of competing geoacoustic models in order to judge which model explains the data most efficiently.

The results of this research are documented in [1-2].

References

[1] D.J. Battle, P. Gerstoft, W.A. Kuperman, W.S. Hodgkiss, and M. Siderius, "Geoacoustic inversion of tow-ship noise via near-field-matched-field processing," IEEE J. Oceanic Engr. 28(3): 454-467 (2003).

[2] D.J. Battle, P. Gerstoft, W.S. Hodgkiss, W.A. Kuperman, and P.L. Nielsen, "Bayesian model selection applied to self-noise geoacoustic inversion," J. Acoust. Soc. Am. (in press, October 2004).

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15. SUBJECT TERMS

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